Trials@uspto.gov
571-272-7822

Paper 42
Entered: June 26, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GENERAL ELECTRIC COMPANY,
Petitioner,

v.

UNITED TECHNOLOGIES CORPORATION,
Patent Owner.

Case IPR2016-00531
Patent 8,511,605 B2

Before HYUN J. JUNG, SCOTT A. DANIELS, and
GEORGE R. HOSKINS, *Administrative Patent Judges.*

DANIELS, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. Background

General Electric Company ("Petitioner" or "GE") filed a Petition requesting *inter partes* review of claims 1, 2, and 7–11 of U.S. Patent No. 8,511,605 B2 (Ex. 1001, "the '605 patent"). Paper 1 ("Pet."). GE's Petition is supported by declarations from Dr. Reza Abhari (Ex. 1003, "Abhari Declaration," and Ex. 1036, "Abhari Reply Declaration"). Pet. 4. United Technologies Corp. ("Patent Owner" or "UTC") filed a Preliminary Response. Paper 6 ("Prelim. Resp."). On June 30, 2016, the Board instituted a trial, determining that GE had shown a reasonable likelihood of prevailing on at least one of the challenged claims of the '605 patent. Paper 7 ("Inst. Dec.") 2.

After institution of trial, UTC filed a Patent Owner Response, along with declarations by Dr. Jack Mattingly (Ex. 2009, "Mattingly Declaration") and Mr. Paul Duesler (Ex. 2022, "Duesler Declaration"). Paper 15 ("PO Resp."). GE entered subsequently a Reply (Paper 24, "Pet. Reply"). In a motion authorized by the Board, UTC also moves to strike certain portions of the Abhari Reply Declaration and GE's Reply. Paper 30. GE provided a rebuttal to UTC's motion. Paper 34.

Notably, UTC disclaimed claims 1 and 2 of the '605 patent leaving only claims 7–11 at issue in this proceeding. PO Resp. 5.[1]

A hearing for IPR2016-00531 was held on May 4, 2017. The transcript of the hearing has been entered into the record. Paper 41 ("Tr.").

---

[1] UTC filed a Disclaimer under 37 C.F.R. 1.321 of claims 1–6 and 12–14 in the '605 patent with the USPTO on October 14, 2016. For completeness of the record, we enter the Disclaimer as Exhibit 3001.

We have jurisdiction under 35 U.S.C. § 6(c). This final written decision is issued pursuant to 35 U.S.C. § 318(a).

GE has not shown by a preponderance of the evidence that claims 7–11 of the ’605 patent are unpatentable, and UTC’s motion to strike is denied.

B. Additional Proceedings

In addition to this petition, GE has filed a petition challenging the patentability of claims 1–6 and 12–16 of the ’605 patent. *See* IPR2016-00533. GE indicates that they are unaware of any litigation involving the ’605 patent. Pet. 1; *see also* Paper 5, 2 (Patent Owner indicating the same).

C. The ’605 Patent

The ’605 patent issued August 20, 2013 from an application filed May 31, 2012, and claims priority as a continuation-in-part from application No. 12/131,876, filed June 2, 2008, now U.S. Pat. No. 8,128,021. Ex. 1001, cover page. The ’605 patent is titled “Gas Turbine Engine With Low Stage Count Low Pressure Turbine.” *Id.* at 1:1–2. Figure 1A, reproduced below, illustrates the invention:

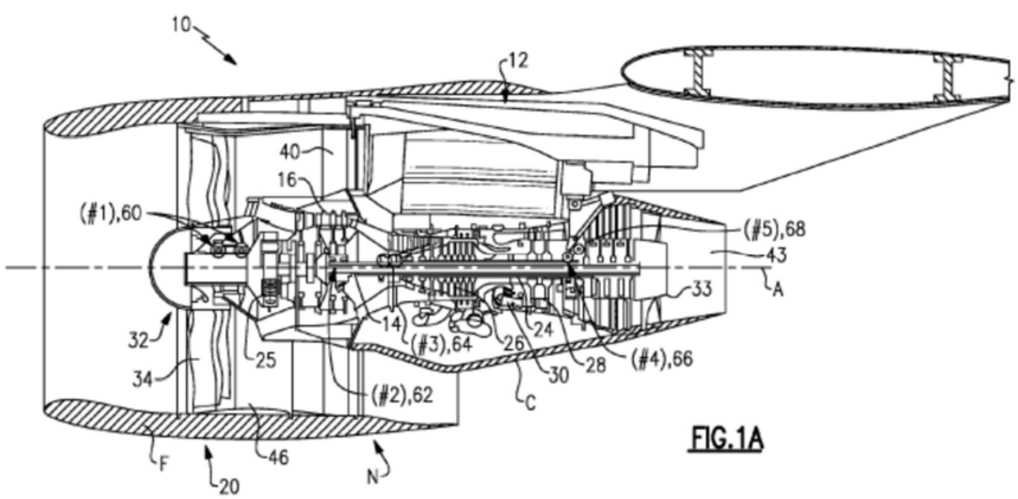


FIG.1A

Figure 1A depicts a partial fragmentary schematic view of gas turbofan engine 10 suspended from engine pylon 12. *Id.* at 3:32–34.

Turbofan 10 includes fan section 20 within fan nacelle F and a core engine within core nacelle C. *Id*. at 3:36–39, Fig. 1A. In operation, airflow enters fan nacelle F, which at least partially surrounds core nacelle C. *Id*. at 3:66–67. The fan passes air both into the core engine (core air flow) and around the core engine (bypass air flow). *Id*. The bypass air flow provides a certain amount of the engine thrust as does the core engine, and the low pressure turbine in the core drives the fan. *See id.* at 4:2–12, 4:42–43.

In one described embodiment relevant to the remaining ground in this proceeding, a Variable Area Fan Nozzle, ("VAFN"), varies the fan nozzle exit area in order to adjust the pressure ratio of the fan bypass airflow. *Id.* at 4:31–34. We note the VAFN mechanism is not, apparently, depicted in any of the figures in the '605 patent. *See* Ex. 1001, Figs. 1–5, *and see* Tr. 5:2. According to the '605 patent, the VAFN's ability to selectively adjust the pressure ratio of the bypass air flow, "allows the engine to change to a more favorable fan operating line at low power, avoiding the instability region, and still provide the relatively smaller nozzle area necessary to obtain a high-efficiency fan operating line at cruise." *Id*. at 4:37–41.

D. Illustrative Claims

The remaining challenged claims are claims 7–11. Claims 1 and 7 illustrate the claimed subject matter and are reproduced below:

> 1. A gas turbine engine comprising:
>
> a gear train defined along an engine centerline axis;
>
> a spool along said engine centerline axis which drives said gear train, said spool includes a low stage count low pressure turbine
>
> a fan rotatable at a fan speed about the centerline axis and driven by the low pressure turbine through the gear train, wherein the fan speed is less than a speed of the low pressure turbine;

a core surrounded by a core nacelle defined about the engine centerline axis;

a fan nacelle mounted at least partially around said core nacelle to define a fan bypass airflow path for a fan bypass airflow, wherein a bypass ratio defined by the fan bypass passage airflow divided by airflow through the core is greater than about ten (10).

7. The engine as recited in claim 1, further comprising:

a fan variable area nozzle *axially movable* relative said fan nacelle to *vary a fan nozzle exit area* and *adjust the fan pressure ratio* of the fan bypass airflow during engine operation.

Ex. 1001, 7:43–8:7, 8:19–23 (emphasis added). Claims 8–11 depend directly or indirectly from claim 7.

E. The Alleged Ground of Unpatentability

GE contends that the challenged claims are unpatentable on the following specific ground.[2]

References	Basis	Claims Challenged
Willis[3] and Duesler[4]	§ 103	7–11

II. CLAIM CONSTRUCTION

UTC asserts no construction for any claim terms. *See* PO Resp. Although GE proposed constructions for a number of claim terms in its Petition (Pet. 12–22), neither party disputes our initial determination that no claim term requires construction. *See* Inst. Dec. 5, *and see Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (only those

[2] GE supports its challenge with the Abhari Declarations (Exs. 1003, 1036). *See infra*.

[3] William S. Willis, *Quiet Clean Short-Haul Experimental Engine (QCSEE) Final Report* (Aug. 1979) (Ex. 1011).

[4] US 5,778,659 (July 14, 1998) (Ex. 1006 or Duesler '659).

terms which are in controversy need to be construed, and only to the extent necessary to resolve the controversy).

III. ANALYSIS

A. Claims 7–11 — Alleged obviousness over Willis and Duesler

GE asserts that claims 7–11 would have been obvious over Willis and Duesler. Pet. 31–43. A patent is invalid for obviousness:

> if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

35 U.S.C. § 103. Obviousness is a question of law based on underlying factual findings: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the art; and (4) objective indicia of nonobviousness. *See Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17–18 (1966). We must consider all four Graham factors prior to reaching a conclusion regarding obviousness. *See Eurand, Inc. v. Mylan Pharms., Inc.* (*In re Cyclobenzaprine Hydrochloride Extended-Release Capsule Patent Litig.*), 676 F.3d 1063, 1076–77 (Fed. Cir. 2012). As the party challenging the patentability of the claims at issue, GE bears the burden of proving obviousness by a preponderance of the evidence. *See* 35 U.S.C. § 316(e).

B. Scope and Content of the Prior Art

1. Willis

Willis, titled "Quiet Clean Short-Haul Experimental Engine," describes "the design, fabrication, and testing of turbofan propulsion systems for two short-haul transport aircraft and delivery of these systems to NASA for further testing." Ex. 1011, 019. The developed engines use low-pressure ratio fans at lower fan tip speeds, and also include "[a] variable-area fan-exhaust nozzle [] necessary to keep the fan pressure ratio from dropping too low at cruise." *Id.* at 026. Figure 8 depicts the Under-the-Wing (UTW) version of Willis' turbofan engine, Figure 8 is reproduced below:

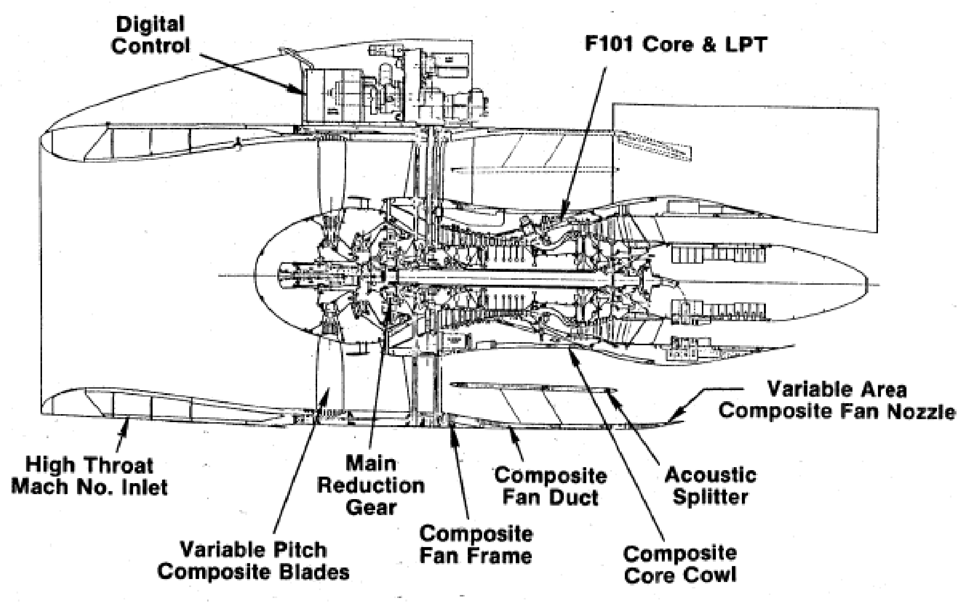


Figure 8. UTW Engine Cross Section.

As depicted in Figure 8 the UTW engine comprises a fan with variable pitch composite blades, a two-stage power turbine driving a star - type, epicyclic main reduction gear, which in turn drives the fan, and, a variable area fan nozzle. *Id*. at 032–033. Willis depicts a radially hinged flap acting as a VAFN, labeled "Variable Area Composite Fan Nozzle," in Figure 8, above. Willis explains that in Figure 8 "[t]he fan nozzle is shown in the cruise position. It opens part way for takeoff and approach and further for reverse, where it functions as an inlet." *Id*. at 032.

2. Duesler '659

Duesler '659 describes a variable area fan exhaust nozzle for an aircraft gas turbine engine. Ex. 1006, 1:12–20. An annotated version of

Figure 2 depicts the downstream portion of outer nacelle 20 with translating sleeve 38, which we highlight in yellow, Figure 2 annotated is reproduced below:

FIG.2

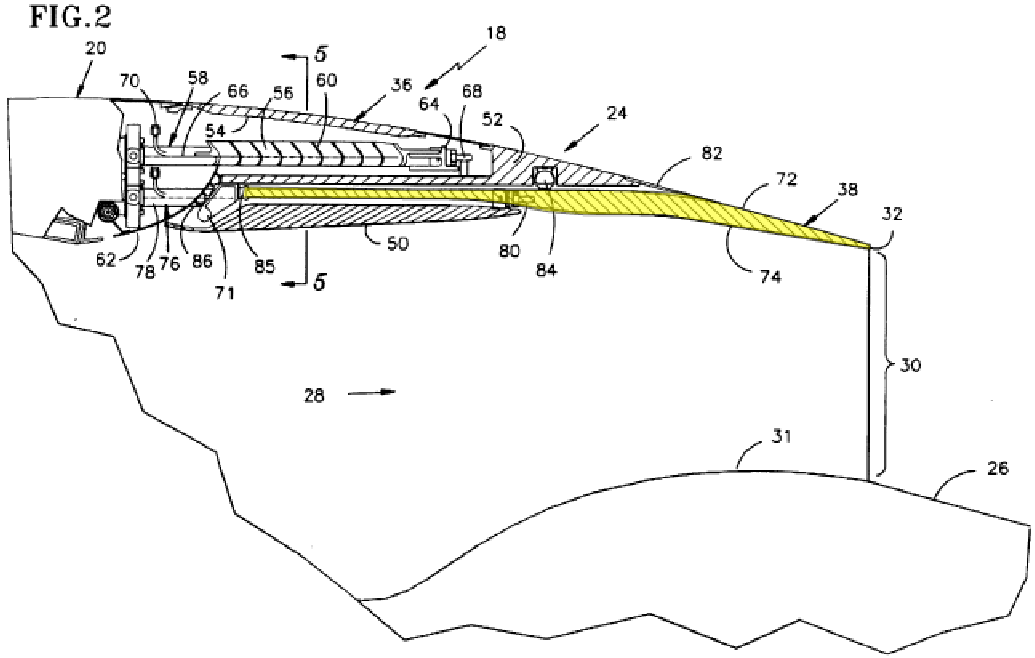


Figure 2, as annotated above, depicts downstream portion 24 of outer nacelle 20 including fixed geometry fan exhaust nozzle translating sleeve 38 disposed in a stowed position. *Id*. at 4:22–26, 49–51. The sleeve is translatable between the stowed position and a deployed position, illustrated below, in Figure 3. *Id*. at 4:52–55.

FIG.3

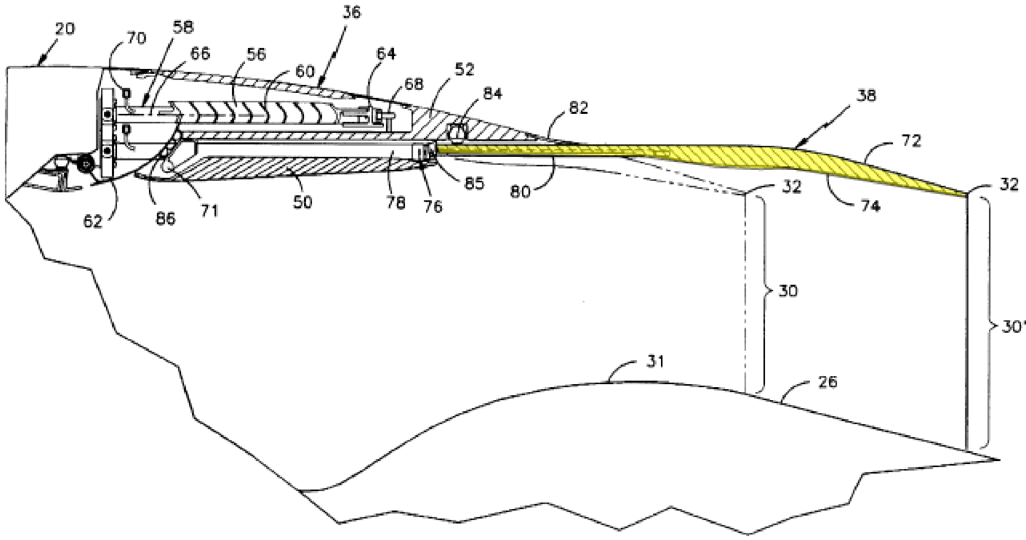


Figure 3 depicts fan exhaust nozzle translating sleeve 38, highlighted in yellow, disposed in a deployed position. *Id.* As shown by comparing reference numbers 30 and 30′ in Figure 3, aftward movement of the sleeve causes an increase in the throat area while forward movement causes a decrease in the throat area. *Id*. at 4:58–61. This movement between the stowed and deployed positions is the exclusive means for varying the throat area and the quantity of forward thrust from gases discharged from the duct. *Id*. at 4:55–58.

C. Differences Between the Prior Art and the Claimed Invention

Claim 1

Claim 7 depends directly from claim 1, and by its dependency, includes all the limitations of claim 1. *See* Ex. 1001, 7:43–8:7, 8:19–23. GE argues that Willis anticipates and discloses each limitation in claim 1. Pet. 24–31. UTC has now disclaimed claim 1. PO Resp. 5. We were persuaded in our Decision to Institute that GE "demonstrated a reasonable likelihood of prevailing at trial on its challenge of claims 1 and 2 as anticipated by Willis." Inst. Dec. 7. UTC presents no arguments in its Response contradicting GE's assertions of anticipation or refuting the Board's anticipation analysis in our Decision to Institute with respect to claim 1.

We adopt GE's contentions as our findings with regard to anticipation of the challenged independent claim 1 because, upon review of the full record in this proceeding, the cited portions of Willis reasonably support GE's assertions that the elements of claim 1 are known and explicitly shown by Willis. *See* Pet. 24–31 (citing Exs. 1003 ¶ 64–72; 1011, .024, .026, .032, .034, .088, .092, .135).

Claim 7

To meet the "fan variable area nozzle axially moveable" limitation recited in claim 7, GE relies on Duesler's translating sleeve 38 in combination with Willis. Pet. 31–37. GE contends that "Duesler discloses a variable area fan nozzle that varies the nozzle exit area with an axially movable sleeve." Pet. 32–33 (citing Ex. 1006, 2:48–58; Ex. 1003 at ¶ 75). GE asserts that a person of ordinary skill in the art would have known about different structures for varying the fan nozzle exit area and that "a variable area fan nozzle could include a plurality of flaps actuated in the radial direction, *or* a sleeve that is actuated in the axial direction." *Id.* at 33 (emphasis added) (citing Ex. 1006, Ex. 1008).

Relying on its declarant, Dr. Abhari, a Professor of Aerothermodynamics and the Director of the Laboratory for Energy Conversion in Zurich, Switzerland, GE argues that substituting translating sleeve 38 of Duesler, for the flaps in Willis is just a design choice, and, "simply the application of a known structure to achieve a predictable result (adjusting the nozzle exit area)." *Id.* at 33 (citing Ex. 1003 ¶ 77). Dr. Abhari opines that one of ordinary skill in the art understands that the hinging flap structure in Willis is interchangeable with sleeve 38 from Duesler to serve the same purpose, i.e. varying the fan nozzle exit area. Ex. 1003 ¶ 77 ("The radially moveable flaps and axially moveable sleeve are both known structures used for the same purpose—varying the fan nozzle exit area."). Dr. Abhari states for example that hinged flaps "can be advantageous for military applications (e.g., fighter jets) that require optimal performance and maneuverability." *Id.* ¶ 78 (citing Ex. 1014, .100–.101). On the other hand, by using a translating sleeve "airflow leakage is minimized because the nozzle is comprised of only a few components and therefore has a relatively continuous inner surface." *Id.* (citing Ex. 1006, 3:21–25). Size, weight, and cost are other factors noted by Dr. Abhari for choosing one structure over the other. *Id.*

UTC disagrees with Dr. Abhari's assertion that substituting Duesler's translating sleeve 38 for Willis's radially moveable flaps is simply a matter of "design choice." PO Resp. 28. UTC points out that the primary objective of the Willis engine was specifically to have a high reverse-thrust for very short runways. *See id.* at 29 ("creating an engine capable of effective reverse thrust and very low noise was Willis's intended purpose and principle of operation"). UTC argues that the "proposed substitution would change the principles under which the Willis engine was designed to operate and render the engine unsuitable for its intended purpose." *Id.* at 30 (citing *Plas-Pak Indus., Inc. v. Sulzer Mixpac AG,* 600 F. App'x 755, 758 (Fed. Cir. 2015)).

Specifically, UTC argues that "Duesler's translating-sleeve nozzle can only serve effectively as an exhaust *and not an inlet*, so it could never meet the reverse-thrust requirements that are central to Willis's mission." *Id.* at 2–3. In support of this position UTC provides testimony from Dr. Jack D. Mattingly, Professor Emeritus of Mechanical Engineering at Seattle University College of Science and Engineering. Ex. 2009 ¶ 3. Also, UTC presents testimony from Paul W. Duesler, the first named inventor of the Duesler '659 patent. *See* Ex. 2022; *see also* Ex. 1006, "Cover Page." Based on Dr. Mattingly's testimony, UTC alleges that one of ordinary skill in the art would not combine Duesler with Willis because Duesler "would render Willis's engine inoperable for its intended purpose." PO Resp. 29. Specifically, UTC contends that using Duesler's sleeve would make Willis's reverse-thrust "performance worse" and the engine "too loud" for Willis's stated noise design requirements. *Id.* at 35–36.

We agree with GE that Duesler's translating sleeve 38, and the pivoting flaps used in the Willis engine, accomplish at least one common task, that is—varying the fan outlet area. *Compare* Ex. 1006, 2:66–3:1 *with* Ex. 1011, .032 (Willis's "[fan nozzle] opens part way for takeoff and approach and further for reverse, where it functions as an inlet."). Both Dr. Abhari and Dr. Mattingly provide testimony supporting the determination that Duesler and Willis both disclose a variable area fan nozzle (VAFN). *Compare* Ex. 1003 ¶¶ 75–77 *with* Ex. 2009 ¶¶ 51, 65. The question addressed below is whether one of ordinary skill in the art would have, as a matter of design choice and given that both structures vary the fan outlet (exhaust) area of a turbofan engine, substituted Duesler's axially translating sleeve nozzle configuration for the radially hinged VAFN structure in Willis?

D. The Level of Ordinary Skill in the Art

GE's declarant, Dr. Abhari, testifies that a person of ordinary skill in the art "would include someone who has a M.S. degree in in Mechanical Engineering or Aerospace Engineering as well as at least 3–5 years of experience in the field of gas turbine engine design and analysis." Ex. 1003 ¶ 4. Disagreeing with Dr. Abhari's opinion as to the years of experience one of ordinary skill would have in this field, Dr. Mattingly states that:

> a person of ordinary skill in this art would have . . . at least ten years of work experience or equivalent study in the design of gas turbine engines for aircraft. Persons of ordinary skill in the art typically have worked as component designers, gained familiarity with engine components, and then been promoted to system-level design responsibilities.

Ex. 2009 ¶ 40.

The difference in opinion between declarants fails mainly to settle on a time frame, i.e. years of experience, in aircraft gas turbine engine design, that a person of ordinary skill in the art would generally have. These positions, however, are not as far afield as they might seem. We recognize from Dr. Abhari's and Dr. Mattingly's testimony that gas turbine aircraft engines and their operating conditions are functionally and structurally complex. *See* Ex. 1003 ¶¶ 21, 53, 55, 60; Ex. 2009 ¶ 38. From the testimony of both declarants we understand that a person of skill in the art of aircraft turbine design is not a newly minted mechanical or aeronautical engineer fresh from undergraduate, or even graduate studies, without a number of years of work experience in the field of aircraft engine design. *See* Ex. 1003 ¶ 4, *and see* Ex. 2009 ¶ 40. Our review of the prior art in conjunction with the declarants' testimony informs us of the complexity of the structural and functional aspects of aircraft engine design and indicates that the level of ordinary skill in the art of aircraft turbofan engine design is fairly high, requiring significant time working in the field. We reconcile the declarants' inconsistent statements as to years of work experience by determining that a person of ordinary skill in the art of gas turbine engines for aircraft would have a professional background that includes at least an M.S. degree in mechanical or aeronautical engineering and, along with whatever additional engineering background knowledge and skill set they possess, at least 5–10 years of work and study experience in design and analysis of aircraft gas turbine engines. We point out that regardless of the difference in years of experience asserted by the declarants, our ultimate findings and conclusions would be the same under either definition.

E. Secondary Considerations of Non-Obviousness

Evidence of secondary considerations of non-obviousness, when present, must always be considered en route to a determination of obviousness. *See Cyclobenzaprine*, 676 F.3d at 1075–76. However, the absence of secondary considerations is a neutral factor. *See Custom Acc., Inc., v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 960 (Fed. Cir. 1986). Neither party introduced evidence on secondary considerations of nonobviousness. Consequently, we will focus our attention on the first three *Graham* factors.

F. Whether the Prior Art Could Have Been Combined and/or Substituted to Achieve the Claimed Invention

The Supreme Court instructs us to take an expansive and flexible approach in determining whether a patented invention was obvious at the time it was made. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 415

(2007). Where "a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield predictable results." *Id.* at 416. It is well settled, however, that prior art combinations cannot change the "basic principles under which the [prior art] was designed to operate." *In re Ratti,* 270 F.2d 810, 813 (1959). Also, a combination that renders prior art "'inoperable for its intended purpose,' may fail to support a conclusion of obviousness." *Plas-Pak Indus., Inc. v. Sulzer Mixpac AG*, 600 F. App'x 755, 757–58 (Fed. Cir. 2015) (citing *In re Gordon,* 733 F.2d 900, 902 (Fed. Cir. 1984)).

UTC argues that the proposed combination changes the principle of operation of Willis's engine, and would make Willis's engine inoperable for its intended purpose by having decreased reverse-thrust capability that could not stop an aircraft on a short runway, and that it would also make the engine noisier. PO Resp. 30. Alleging that the Willis engine would, thus, become unsuitable for its intended purpose of powering "a fleet of new aircraft that would operate from smaller airports close to city centers," (Ex. 1011, .024) UTC asserts that a person of ordinary skill in the art of gas turbine aircraft engine design would not simply substitute Duesler's translating sleeve for Willis's pivoting flap design. *Id.*

The stated objective of the Willis engine development program was "to develop the technology needed to meet the stringent noise, exhaust emissions, performance, weight, and transient thrust-response requirements of future short-haul aircraft" so aircraft could land in smaller airports closer to population centers. Ex. 1011, .019, .024. These objectives were based on

> major problems facing the air transport industry in the early 1970's [including] noise and airport congestion. Noise had

> forced the closing of certain runways, the imposition of curfews at some airports, and the use of special flight restrictions . . . . The congestion problem was manifested by traffic and parking problems, baggage-handling delays, and (especially in bad weather) long delays in departures and arrivals due to congested air space.

Id. at .024. To develop a feasible engine for "short-haul" aircraft that could land on a very short runway in smaller airports, Willis discloses an engine having a variable pitch fan, that is—a fan that is arranged in a pitch angle producing forward thrust, and then moved, i.e. closed, to a pitch angle producing reverse-thrust through the engine. *See id.* at .043 ("During closure, the normal forward flow drops smoothly to zero, then reverse flow is gradually established."). To adequately stop an aircraft, Willis required a combination airflow and pressure ratio across the fan to meet the reverse-thrust objective of 35% of the forward-thrust. *Id.* at .049.

Additionally, as depicted in Willis's Figure 3 another goal was to keep the noise level below a certain level because smaller airports accommodating such short-haul aircraft were closer to busier population centers. *Id.* at .024–.025.

Willis Figure 3 is reproduced below:

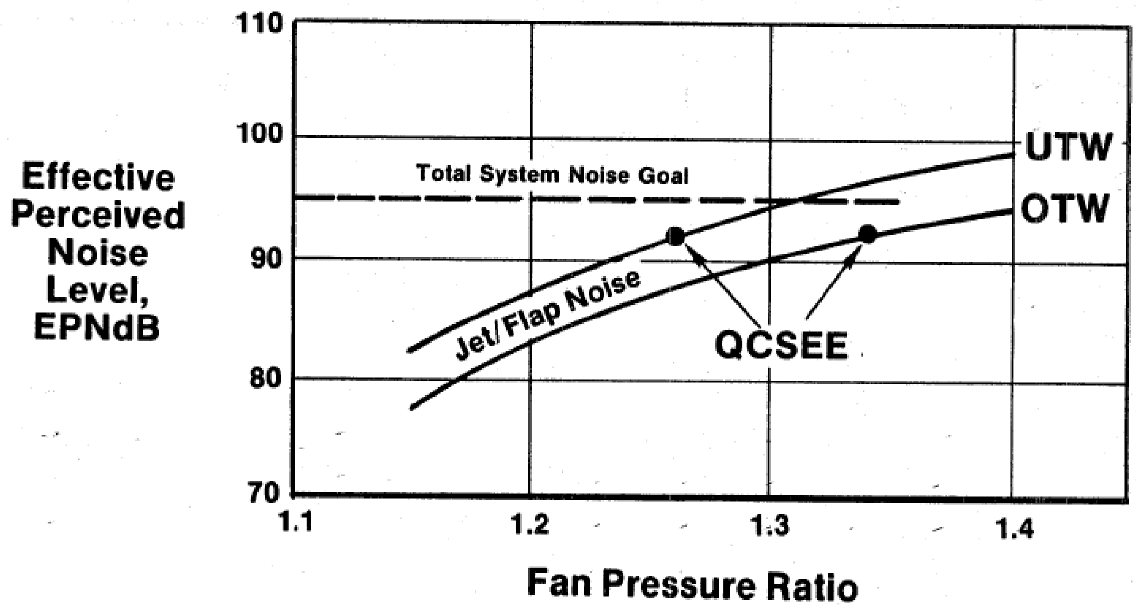


Figure 3. Effect of Jet Flap Noise on Fan Pressure Ratio Selection.

Figure 3 from Willis illustrates graphically fan pressure ratio as a function of noise level, and a desired total system noise goal. *Id.* at .025.

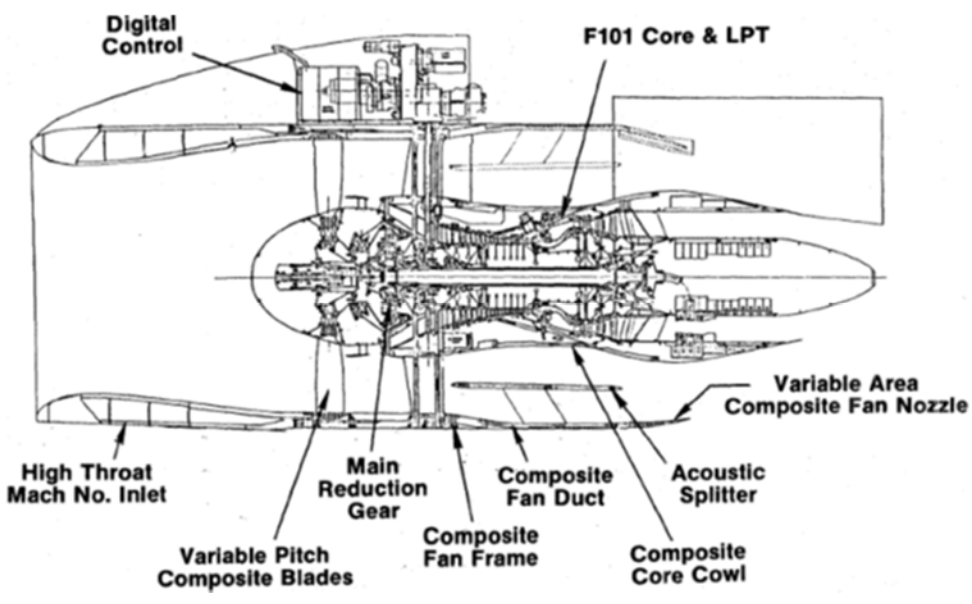
Based on these goals, the structural and functional design requirements for Willis's short-haul engine are quite specific as shown listed, below, in Willis's Table III.

Table III. UTW Design Parameters.

Total Airflow, kg/s (lb/sec)	405.5 (894))
Fan Tip Diameter, cm (in.)	180.3 (71)
Fan Tip Speed, m/s (ft/sec)	289.6 (950)
Bypass Ratio	11.8
Fan Pressure Ratio	1.27
Overall Pressure Ratio	13.7
Jet Velocity (Core), m/s (ft/sec)	244.7 (803)
Jet Velocity (Bypass), m/s	204.2 (670)
Gear Ratio	2.5

Ex. 1011, .034.

A cross-section of Willis's Under-the-wing ("UTW") engine as designed based on the stated objectives and requirements is shown, below, in Figure 8 reproduced from Willis.



Ex. 1011, .033. Willis discloses in Figure 8 an inlet as depicted and labeled on the left side of the figure, and a nozzle defined between the pivoting flaps and the core on the right side of the figure. In the forward-thrust state, the airflow through the fan enters the inlet and emanates from the nozzle. *Id.* at .032. In the reverse-thrust state, the airflow is reversed to help brake the aircraft upon landing, with the air entering the engine through the nozzle and exiting from the engine inlet. *Id.* Willis's nozzle flaps pivot about a connection between the base of the flap and the outer nacelle to vary the fan nozzle area. *Id.* at .134, Fig. 74. Figure 8 illustrates the flaps in a cruise position, and in the image of Figure 74 the flaps are shown, open, in a reverse-thrust position. *Id.* at .032–033, .128, .134. Figure 74 is reproduced below:

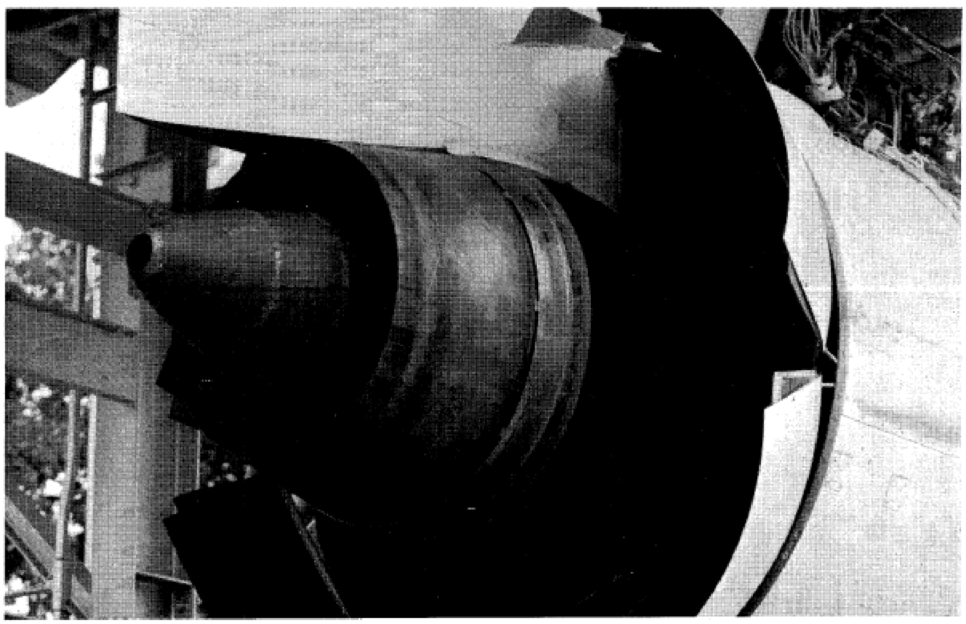


Figure 74. Fan Nozzle.

In the reverse-thrust position shown in Figure 74 Willis's flaps are open, showing how the nozzle structure now acts as an inlet when the variable pitch fan blades are altered to produce a reverse airflow through the engine and hence, reverse-thrust. Ex. 1011, 32, 34–35, 134; Ex. 2009 ¶ 60.

UTC's declarant, Dr. Mattingly, testifies that pivoting flaps "have the ability to open wider than the fan nacelle itself, enabling Willis to draw in the necessary airflow to produce sufficient reverse thrust." Ex. 2009 ¶ 60. Dr. Mattingly explains that the flap structure is important "because most of the airflow does not enter the nozzle in a straight or linear direction, but rather it approaches at a steep angle." *Id.* ¶ 61. Dr. Mattingly provides an annotated Figure from his own textbook, illustrating this steep angle, defined by air having a Mach number close to 0. *Id.* Dr. Mattingly explains that based on such airflow and flap structure "a person of ordinary skill in the art would recognize that the thrust reverser of Willis's UTW engine is an effective design for generating the large amount of reverse thrust (e.g., 35% of max forward thrust) needed to stop quickly on a short-haul runway (2000 feet)." *Id.* ¶ 62. Dr. Mattingly explains further that Duesler's translating sleeve nozzle does not function as an inlet and "the engine would not be able to draw air in over the sharp, axial-direction trailing edge 32 of the sleeve 38." *Id.* ¶ 72.

Hypothesizing that Duesler's sleeve could act as an inlet, Dr. Mattingly offers a summary of inlet area geometry and air flow comparison calculations between Willis's and Duesler's nozzles, asserting that Duesler's nozzle has a 28–37% higher inlet drag, i.e. loss of reverse-thrust, compared to Willis's nozzle. *Id.* ¶¶ 90–94. Based on his calculations of reverse-thrust loss in Duesler, Dr. Mattingly states

> A person of ordinary skill in the art would view this as especially critical to Willis's short-haul goal for an "effective thrust reverser (GE-1011.026) that could produce up to 35% of its forward thrust in reverse (GE-1011.301) and . . . would not view the Willis-Duesler combination as an effective thrust reverser.

Id. ¶ 95.

Dr. Mattingly testifies further that Duesler's translating sleeve would exceed the noise requirements for Willis's engine of "100 dB at a 500-foot sideline for maximum reverse thrust" *Id.* ¶ 95 (citing Ex. 1011, 19). Dr. Mattingly states that

> [a] person of ordinary skill in the art would recognize that attempting to draw in a large amount of air over Duesler's sharp, trailing edge 32 at maximum [reverse] thrust on the UTW engine would generate noise well above Willis's intensity limit. This would have been unacceptable in the congested areas where Willis's short-haul airports are located.

Id. ¶ 96.

In response, GE points out that its obviousness analysis rests simply on the substitution of Duesler's translating sleeve for Willis's flaps.[5] *See* Pet. Reply 4. GE relies mainly on the testimony of Dr. Abhari that both types of variable area nozzles were known in the art at the time of filing of the '605 patent. Pet. 33 (citing Exs. 1006, 1008); Pet. Reply 6 (citing Ex. 1003 ¶ 77; Ex. 2019, 112 at 399:7–14, 128 at 415:5–17). GE points out that Dr. Mattingly was unable to rebut Dr. Abhari's testimony that axially moveable variable area fan nozzles were known in the art. Pet. Reply 7–8.

GE argues also that Dr. Abhari provided sufficient evidence of motivation to combine, i.e. a reason to substitute an axially moveable sleeve for the hinged flaps in Willis because with a translating sleeve "airflow

---

[5] GE takes issue with UTC's analysis of the combination of Duesler's thrust reversing mechanism in addition to the translating sleeve. Pet. 4–5; *see also* PO Resp. 22–25. GE asserts Duesler's thrust reversing mechanism and blocking doors is not part of the combination of references asserted by GE. Pet. Reply 4–5. Our analysis in this Final Written Decision rests only on the asserted substitution of Duesler's translating sleeve 38 for Willis's hinged flaps.

leakage is minimized because the nozzle is comprised of only a few components and therefore has a relatively continuous inner surface." Pet. Reply 9 (citing Ex. 1003 ¶ 78). GE contends further that the "intended purpose" proposed by UTC for Willis's engine is too narrow because "[r]everse thrust mode accounts for several seconds of engine operation, while the engine also must take-off, climb, cruise, and descend." *Id.* at 13. GE argues also that Dr. Mattingly's conclusion that Duesler would be louder than Willis's engine is unsubstantiated by sufficient facts or data and that we should give this testimony no weight. *Id.* at 13–14 (citing 37 C.F.R. § 42.65).

It is GE's ultimate burden of persuasion to show by a preponderance of the evidence that a person of ordinary skill in the art would have been motivated to use an axially translating sleeve in place of Willis's radially hinged flaps. *See Dynamic Drinkware, LLC v. National Graphics, Inc.,* 800 F.3d 1375, 1378 (Fed. Cir. 2015) ("In an *inter partes* review, the burden of persuasion is on the petitioner to prove 'unpatentability by a preponderance of the evidence,' 35 U.S.C. § 316(e), and that burden never shifts to the patentee[.]"). On the other hand, the burden of production, i.e. the burden of going forward with evidence, shifts between parties. *Id.* at 1379.

As noted above, our review of the asserted references, along with the testimony of both Dr. Mattingly and Dr. Abhari, supports the conclusion that Duesler and Willis disclose different structures that perform the function of varying the fan nozzle exhaust area, and thus, are both understood by those of ordinary skill in the art as variable area fan nozzles. *See* Ex. 1006, 4:52–58 *and see* Ex. 1011, .032. Thus, GE's argument that Dr. Mattingly could not "rebut" Dr. Abhari's testimony that such structures were known in the art is of no consequence. Dr. Mattingly, in fact, appears to agree, although he is somewhat reticent to discuss specifics of Duesler's nozzle, and the fact that both Willis and Duesler disclose VAFN's that vary the nozzle exhaust area. *See* Ex. 1033, 90:9–12 ("When I compared the radial variable nozzle of Willis to the axial variable fan nozzle of Duesler, it's my opinion that the Duesler nozzle is heavier.").

Dr. Abhari asserts in his declaration that substituting the axial translating sleeve 38 from Duesler into Willis's engine "is simply the application of a known structure (an axially movable fan nozzle) to achieve a desired and predictable result (changing the nozzle exit area)." Ex. 1003 ¶ 77. Dr. Abhari explained that the choice of whether to use an axial sleeve or a radially hinged flap as a nozzle can depend on certain "factors." *Id.* ¶ 78. For example, Dr. Abhari described that where "thrust vectoring" is desired in military aircraft for maneuverability, a radially hinged flap nozzle is preferable. *Id.* If control of airflow leakage from the nozzle is desired to be minimized for better propulsive efficiency, then a sliding sleeve design is preferable as it "has a relatively continuous inner surface." *Id.* (citing Ex. 1006, 3:21–25). Dr. Abhari also noted that "size, weight and cost" can affect the design choice between variable area nozzle structures. *Id.*

GE contends that Dr. Abhari's testimony supplies adequate reasons and motivation to substitute Duesler's sleeve into Willis's engine particularly where he alleges that by using a translating sleeve design "airflow leakage is minimized . . . which Duesler describes as beneficial to engine performance." Pet. Reply 9 (citing Ex. 1006, 1:53–55). The problem, however, is that Dr. Abhari's asserted "factors" do not substantively explain why or how Duesler's translating sleeve would affect the stated purposes and explicit design parameters of Willis, which are aimed at "develop[ing] the technology needed to meet the stringent noise, exhaust emissions, performance, weight, and transient thrust-response requirements of future short-haul aircraft," as discussed above in our factual findings. We are not apprised by GE or Dr. Abhari of any aspect of Willis that relates specifically to "military aircraft maneuverability." Our review reveals Willis's express objective is developing a turbofan engine intended for "short-haul-transport aircraft" for very short take-off and landing, which requires "a reverse-pitch fan that can provide reverse thrust without heavy, variable-geometry, nacelle components." Ex. 1011, .024, .026. As shown in annotated Table 1, reproduced below, Willis explicitly sets forth program goals and parameters needed to be met by the engine design "to meet the stringent noise, exhaust emissions, performance, weight, and transient thrust-response requirements of future short-haul aircraft." *Id.* at .019.

Table I. QCSEE Program Goals.

Parameter	UTW	OTW
Noise at 152.4 m (500 ft) Sideline		
Takeoff and Approach, EPNdB	95	95
Maximum Reverse Thrust, PNdB	100	100
Exhaust Emissions	1979 EPA Standards for Carbon Monoxide, Unburned Hydrocarbons, and Oxides of Nitrogen	
Performance		
Uninstalled Thrust, kN (lbf)	81.4 (18,300)	93.4 (21,000)
Installed Thrust, kN (lbf)	77.4 (17,400)	90.3 (20,300)
Uninstalled sfc, g/sec/N (lbm/hr/lbf)	0.0096 (0.34)	0.0102 (0.36)
Max Reverse Thrust, % of Max Forward	35	35
Thrust to Weight Ratio, N/kg (lbf/lbm)		
Uninstalled	60.8 (6.2)	72.6 (7.4)
Installed	42.2 (4.3)	46.1 (4.7)
Thrust Transient, seconds		
Approach to Takeoff	1	1
Approach to Max Reverse	1.5	1.5

Exemplary goals for Willis's engine are shown highlighted in yellow in Table 1, above, including maximum desired noise at max reverse thrust of 100 PNdB, max reverse thrust of 35% of forward thrust, and thrust transient characteristics from aircraft landing approach to max reverse of 1.5 seconds.

Willis is replete with structural design characteristics based on the noted goals, such as turbofan variable pitch blades to ensure quick thrust transient from approach to max reverse for braking, with all the engine structural design focused on ensuring that aircraft are capable of take-off and landing on very short runways and meeting specific noise parameters. *See id.* at .026; *see also id.* at .032 ("[r]ecognizing the critical nature of the blade pitch-control system, many concepts were studied, and two variable-pitch systems were built and tested"). Dr. Abhari's general reference to certain "factors" for choosing between different variable nozzle structures fails to address in a meaningful manner any of the express requirements, goals and characteristics discussed in Willis. For example, in order to land on a short runway, the Willis engine must be capable of generating a max reverse thrust of 35% of forward thrust. *Id.* at .019, Table 1. Nowhere does Dr. Abhari provide any estimate, or provide a technical explanation or analysis that sufficiently explains how Willis's engine, equipped with Duesler's axially translating nozzle, could be understood by one of ordinary skill in the art to accommodate such a reverse thrust parameter.

We do not discount entirely Dr. Abhari's testimony, because we find it persuasive as to the general desirability of using variable area fan nozzles to improve fan stability and engine efficiency at cruise. *See* Ex. 1003 ¶ 75. Based on a review of the prior art and both parties' declarant testimony, we find that a person of ordinary skill in the art of gas turbofan aircraft engines would have recognized "that there are a variety of variable area fan nozzle structural configurations possible for effectuating a change in the nozzle exit area." *Id.* ¶ 77, Ex. 1006; Ex. 1008. But, the Willis engine is directed expressly to "short-haul" capabilities including take-offs and landings on very short runways, not to engine efficiency at cruise. *See* Ex. 1011, .024. To be clear, Dr. Abhari's testimony does not go far enough in explaining persuasively why a person of ordinary skill in the art would have substituted Duesler's nozzle into Willis's engine given the express purposes of Willis.

Dr. Abhari testifies that gas turbofan engines are complicated systems that depend on "thousands, often tens of thousands of parts." Ex. 2018, 79:1–2. Dr. Abhari testifies further that aircraft engine design required a "holistic" approach to understand how the engine would perform in all situations and operating conditions including emergency conditions:

> **Q.** I think you mentioned before that the systems, the holistic systems approach is critical, correct?
>
> **A.** Absolutely. You wouldn't function without it.
>
> **Q.** And you would have to look at that in order to have a reasonable expectation of success, correct?
>
> MR FERGUSON: Objection. Outside the scope of the declaration.
>
> **A.** Again this is not within the patent, but holistic design and aircraft engine, the safety of an aircraft engine number one, necessitates understanding how the engine works, not only during one operating condition but during all operating conditions, including emergency conditions that we have to

> anticipate. So the engine does not have just one point that you can take every design point, you have to look at it in a holistic approach of how it would work on a wing, start up, go up to take off, climb, cruise, descend, land turn it off. It has to work as a whole system.

Id. at 82:14–83:10. Dr. Abhari also testifies that the engine development process, including verification and certification, can take years:

> **Q.** And without all this verification testing that you mention; the components, the engine, bird damage, fan blade off, icing, the testing on the wing, you don't have a reasonable expectation of getting verification by the regulators, correct?
>
> **A.** Well, the three major engine manufacturers; Pratt, GE and Rolls Royce have sufficient management to manage the risk that often you don't go all the way down to the final certifications without a significant chance of success. This is why prior to going into certification, which would take many years, three, four, five years, you spend as many as a decade de-risking components, systems and sub systems before you take the management risk of actually going to the most expensive part of the engine development cycle, which is the certification requirements.

Id. at 74:18–75:10. This testimony is at odds with GE's general contention that choosing an axially movable fan nozzle as in Duesler instead of a radially movable nozzle is a simple matter of substitution. Pet. 33–34, Pet.

Reply 5–6. In fact Dr. Abhari's testimony is more consistent with similar testimony from Dr. Mattingly, who states that:

> [a] person of ordinary skill in the art would recognize that the components of gas turbofan engines are complex and interrelated, and that modifying one component may have undesirable impacts on the fluid dynamics and mechanics of other engine components, systems, or the engine as a whole. The '605 patent, for example, discloses a system of components, not just an individual engine component. The disclosed system includes a gas turbine engine comprising a fan, a gear, compressors, a combustor, turbines, a core nozzle, a variable area fan nozzle, and the core and fan nacelles. In my opinion, a person of ordinary skill in the art would also recognize the potential challenges in adapting components from one gas turbofan engine to another.

Ex. 2009 ¶ 38.

We are not persuaded, given the apparent necessity for years of testing, regulatory oversight, and necessity to evaluate the overall system and individual components based on stringent structural and functional requirements of an aircraft turbofan engine, that one of ordinary skill in the art would have been motivated to exchange Willis's hinged flap variable area nozzle for an axially translating sleeve such as Duesler simply because it might be "beneficial to engine performance." Pet. Reply 9 (citing Ex. 1006, 1:53–55). Apart from the alleged potential to overcome "airflow leakage" and "maneuverability" which are not mentioned as any of the express parameters, goals or system requirements in Willis, neither GE nor Dr. Abhari explain sufficiently how an axially translating sleeve would accommodate the very specific requirements and goals mandated for Willis's engine such as those shown above in Table 1.

We are persuaded based on our review of Willis and the record of this proceeding that Willis's variable pitch fan and pivoting flap variable area nozzle are together implemented in turbofan aircraft engine in a manner which provides for solving the unique problems of short-haul aircraft systems as described in Willis. Based on our understanding of the principles of operation of Willis's engine including the necessity for substantial increased reverse-thrust and reduced noise, we find that Duesler's translating sleeve would alter fundamentally the design of Willis's engine for short-haul aircraft.

Under our rules, expert testimony that does not disclose the underlying facts or data on which an opinion is based is entitled to little or no weight. *See* 37 C.F.R. § 42.65(a); *Office Patent Trial Practice Guide*, 77 Fed. Reg. at 48,763; *Rohm & Haas Co. v. Brotech Corp.*, 127 F.3d 1089, 1092 (Fed. Cir. 1997) (nothing in the Federal Rules of Evidence or Federal Circuit jurisprudence requires the fact finder to credit unsupported assertions of an expert witness). We are not inclined to credit such unsubstantiated testimony.

In an obviousness analysis, a reason must be given as to why a person of ordinary skill would have been motivated to modify a reference to achieve the patented invention. *See Innogenetics, N.V. v. Abbott Labs.*, 512 F.3d 1363, 1374 (Fed. Cir. 2008). Furthermore, an obviousness determination requires not only a reason to modify a prior art reference, but also that a skilled artisan in doing so would have perceived a reasonable expectation of success in making the invention. *See Medichem, S.A., v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006). Although GE contends that Dr. Abhari provided sufficient reason to combine, we disagree. *See* Pet.

Reply 8–9. On the record before us, we are not persuaded that GE or Dr. Abhari have presented sufficient evidence that one of ordinary skill in the art of aircraft engine design would simply swap Willis's pivoting flap variable area nozzle for Duesler's translating sleeve and that Willis's engine would continue as a technically feasible solution to the specific and express "short-haul" aircraft concept that Willis's engine was designed to accomplish.

G. Ultimate Conclusion of Obviousness as to claims 7–11

After considering all of the underlying factual considerations, the ultimate conclusion of obviousness is a question of law. *See Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1359 (Fed. Cir. 2007). "[T]he great challenge of the obviousness judgment is proceeding without any hint of hindsight." *Star Scientific, Inc., v. R.J. Reynolds Tobacco Co.*, 655 F.3d 1364, 1375 (Fed. Cir. 2011). After considering GE's obviousness presentation under the *Graham* factors and GE's lack of evidence on how or why a person of ordinary skill in the art would have modified Willis's engine to achieve the patented invention, we conclude that GE has failed to establish by a preponderance of the evidence that claim 7 is obvious.

In view of our determination that GE has failed to establish that dependent claim 7, as it also incorporates independent claim 1, would have been obvious, it necessarily follows that GE has failed to establish that dependent claims 8–11 which depend from claim 7 are unpatentable as obvious. *See In re Fritch*, 972 F.2d 1260, 1266 (Fed. Cir. 1992) (dependent claims are nonobvious if the independent claims from which they depend are nonobvious).

H. Patent Owner's Motion to Strike

In an Order entered February 10, 2017, we authorized UTC to file a paper in the form of a list providing the location and a concise description of any portion of GE's Reply and Dr. Abhari's supplemental declaration that UTC wished to draw to the Board's attention. *See* Paper 27. In its Motion to Strike (Paper 30), UTC noted pages 15–22 in GE's Reply Brief, and ¶¶ 6–8 of Dr. Abhari's supplemental declaration. Paper 30. We address each of these issues below.

GE's Reply Brief at the noted pages contends that the combination of Willis and Duesler would produce an effective amount of reverse thrust and that the effects of flow separation are overstated by UTC's declarants, Dr. Mattingly and Paul Duesler. Pet. Reply 15. GE also relies on a patent (Exhibit 1031), to Rolls Royce, U.S. Patent No. 3,820,719 ("the '719 patent") alleging that the '719 patent discloses an axially translating variable area nozzle that promoted reduced flow separation. *Id.* at 19–20.

The arguments in GE's Reply with respect to the issue of flow separation are not persuasive because they do not provide substantive evidence relating to flow separation or reverse thrust analysis in Duesler's translating sleeve, assuming it were to act as an inlet for reverse-thrust (as opposed to an outlet). *Id.* at 15. GE contends mainly that the Willis engine also has "flow separation." *Id.* at 16–17.

We note initially that we did not rely on Mr. Duesler's testimony in our Decision. *See id.* at 17–18. Dr. Mattingly, however, explained in reasonable technical detail, why Willis's flaps, as compared to Duesler's sleeve, permit higher airflow in reverse thrust at a Mach number closer to 0, apparently despite some flow separation in a reverse thrust mode. *See*

Ex. 2009 ¶¶ 59–61 ("In reverse thrust mode, the air entering Willis's UTW engine would follow the wide streamline corresponding to nearly $M_0 = 0$, annotated above. Willis's flaps open widely in reverse thrust mode to accommodate this streamline."). GE's position that there is also flow separation occurring in Willis does not persuasively contradict Dr. Mattingly's testimony.

GE raises substantively Rolls Royce's '719 patent (Ex. 1031), for the first time in its Reply Brief in support of its position that axially movable nozzles were known to be used with a variable pitch fan engine and "the Rolls Royce 719 Patent would have provided a person of ordinary skill in the art with reasonable design modifications for combining Willis and Duesler." Pet. Reply 19. GE contends that its assertion of the '719 patent, apparently as evidence of what was known in the art, is in response to UTC's arguments in its Patent Owner's Response that the combination of Willis and Duesler would decrease the effective reverse thrust and make the engine louder. *See id.*, *and see* Paper 34, 7 (citing PO Resp. 29, 32–35). During the oral hearing, the parties cited various case law and Board decisions alleged to support their positions on this issue. *See* Tr. 27–29, 4–35.

We do not need to decide if GE's evidence and arguments are contrary to 35 U.S.C. § 312(a). Even if these contentions are not new argument and evidence, they are not persuasive. The disclosure in the '719 patent relating to the axially moving nozzle forming an opening 76 defining an "additional intake area" may facilitate additional attached air flow into the engine during reverse-thrust, but it fails to adequately explain how this would achieve the express goals of 35% reverse-thrust and noise abatement in the range of 100 PNdB expressed in the Willis short-haul engine design. *See* Ex. 1031, 3:59–4:9. GE fails to point to any persuasive evidence in the ’719 patent, or elsewhere, that explains how, even assuming the specific structure of the ’719 patent axially moving nozzle somehow provided a known design modification, the axially moving sleeve would meet the fundamental goals of reverse-thrust and noise abatement of the Willis short-haul engine design.

Dr. Abhari’s reply declaration similarly does not provide any persuasive evidence as he echoes GE’s argument, above, stating that flow separation “is a common design concern for turbofan engine inlets.” Ex. 1036 ¶ 6. Dr. Abhari reiterates also GE’s argument that the ’719 patent combines an axially moveable nozzle and a variable pitch fan to “produce an effective amount of reverse thrust.” *Id.* ¶ 8. Although we understand from the evidence before us that an axially moveable nozzle and a variable pitch fan may have produced a potentially workable engine, the term “effective amount” is entirely undefined and falls short of a reasonable explanation or analysis as to how one of ordinary skill in the art would been motivated, or led, towards combining an axial translating nozzle with Willis’s variable pitch fan in order to meet the reverse-thrust requirements for the Willis short-haul engine design.

We are not persuaded that GE’s Reply or Dr. Abhari’s supplemental declaration provide any additional argument or evidence that one of ordinary skill in the art would have combined Willis and Duesler to meet the claimed invention. Therefore, we need not determine whether or not GE’s raising such additional arguments contain new argument or new evidence such as precluded under 35 U.S.C. § 312(a). Accordingly, we DENY UTC's Motion to Strike.

IV. ORDER

For the reasons given, it is ORDERED that

Claims 7–11 of U.S. Patent No. 8,511,605 B2 have not been shown to be unpatentable as obvious over Willis and Duesler, and

Patent Owner's motion (Paper 30) is *denied*.

This is a final decision. Parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

For PETITIONER:

Brian Ferguson
Anish Desai
Christopher Pepe
WEIL, GOTSHAL & MANGES LLP
brian.ferguson@weil.com
anish.desai@weil.com
christopher.pepe@weil.com

For PATENT OWNER:

M. Andrew Holtman
Jeffrey C. Totten
James D. Stein
Patrick J. Coyne
FINNEGAN, HENDERSON, FARRABOW, GARRETT & DUNNER, LLP
andy.holtman@finnegan.com
Jeffrey.totten@finnegan.com
james.stein@finnegan.com
Patrick.coyne@finnegan.com
UTC-IPR@finnegan.com

Michael J. Valaik
BARTLIT BECK HERMAN PALENCHAR & SCOTT LLP
michael.valaik@bartlit-beck.com